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IMPACTING INSTRUMENT FOR GAMES WITH A PLAYING OBJECT
MOVED IN AN IMPACTING OR INTERMITTENT MANNER

The invention relates to an impacting instrument for games with a playing object moved in an impacting or intermittent manner. These games include, among others, hockey, golf and baseball.

The impacting instrument includes an actuation part, which is also referred to, in brief, as "stick", with a short extension part, called a "shaft", as well as a handle and an impact part, for example, in the form of a blade or a club, entering into direct, dynamic operative connection with the playing object. Various constructions of instruments of this type, also known as bats, clubs or rackets, are on the market and generally known. The impact part is subjected directly to a strong, dynamic stress by the play body, which strikes it at high speed. The dynamic stress is composed essentially of pulse-like impact forces with very steep flanks, which are transferred to the stick and, with that, also to the handle. The stick and the impact part are constructions, which are able to vibrate and, due to the frequencies contained in the pulse flanks, can be excited to oscillate at their characteristic vibrations. Because of the existing coupling, the vibrations are also transferred to the actuating part, especially the handle and, with that, also to the hand and/or the arm of the player.

Depending on their frequency and amplitude, such vibrations have an appreciable potential for interfering with the playing process, for instance, with regard to the differentiated and sensitive dosing of the hardness of the shot or of the return speed desired by the player, as well as with regard to the precise determination of the return direction. Last, but not least, physically damaging effects may also arise therefrom for the player. In this connection, summary and/or roughly dimensioned

damping measures have proven to be not very effective or unsatisfactory since, in general, the necessary reflection capabilities of the racket are also affected thereby, as is, in general, also the stroke as sensed by the player.

It is therefore an object of the invention to create a construction, which makes possible a better adaptation of the vibrational behavior to the circumstances of the playing processes and the requirements and peculiar features of the player. The inventive solution of this objective is determined by the distinguishing features of claim 1. Distinguishing features of further significant developments and optimizations of the invention are defined in the claims that follow.

The mode of action of the distinguishing features of the construction of claim 1 depends, among other things, on the effect of the characteristic vibration spectrum of the impacting instrument as a whole. A first step in this connection is the making available of a plurality of singular three-dimensional and/or two-dimensional and/or one-dimensional regions, which differ due to vibrationally relevant, especially resonance relevant, material and/or shape and dimensional parameters of their respective surroundings. Moreover, in practice, as large a number as possible of such singular regions is to be aimed for. These singular regions are then to be arranged in the form of at least one sequence, which extends over at least a portion of the impacting instrument and corresponds to at least one ordered sequence, especially to a mathematically or also an algorithmically determinable series. In practice, comparatively large numbers of sequences, which are to be arranged on the impacting instrument, once again come into consideration here.

Since the singular regions, with their mutual distances and, with that, also with the sequences, are disposed at or in the impacting instrument, the latter represent subdivisions of the vibrating body. In relation to the original, that is, not

subdivided vibrating body, this leads to additional and, moreover, in general, higher characteristic vibrations and also to an elevation in the original characteristic vibrations, that is, to a correspondingly changed characteristic vibration spectrum. At the same time, the characteristic vibration density and its distribution over the frequency band in question can be modified and adapted or optimized in various ways in accordance with the given functional requirements by different configurational measures involving the construction and the dimensions as well as the selection of the material of the singular regions and the sequences.

During the impingement with an impact, the energy of which is distributed over a broad frequency range as a result of its flanks, which have become steep in the course of time, the characteristic vibrations of the changed impacting instrument are stimulated with correspondingly higher frequency distribution in accordance with the now given spectrum, which has a point of concentration, which lies generally at higher frequencies. However, since the amplitude of the vibrations at a given vibrational energy decreases as the frequency increases, the vibrational amplitudes, at any rate, in general, are decreased as a result of the organization of the vibrating bodies with the sequences of the singular regions. However, since it is especially the vibrational amplitudes, which are perceived by the player and can affect the playing quality, the basic inventive construction is suitable for accomplishing the object of the invention.

The mode of action and the advantages of the invention and of the distinguishing features of its essential further developments are explained in greater detail by means of the examples, which are shown diagrammatically in the drawings, of which

- Figure 1 shows a first embodiment of an inattentive impacting instrument with a plan view of the impact part,
- Figure 2 shows a partially longitudinal section of a tubular handle with an external sequence of singular regions,
- Figure 3 shows a partially longitudinal section of a tubular handle with an external and an internal sequence of singular regions and
- Figure 4 shows a partial perspective view of a handle with an organization of sequences of singular regions, extending multidimensionally,
- Figure 5 shows a hockey stick, the shaft part of which has thickenings, which, in the longitudinal direction of the shaft, are disposed in sequence with respect to their axial distances from one another as well as their axial width and/or their radial thickness,
- Figure 6 shows a hockey stick, the shaft of which has an arrangement of ring-like thickenings, similar to those of Figure 5, which are constructed in each case concentrated on the regions extending in the longitudinal direction of the shaft,
- Figure 7 shows a baseball bat, the impact part of which, which is constructed, for example, cylindrically here, has ring-like singular regions, which are disposed consecutively in the longitudinal direction of the cylinder with varying distances from one another and also have varying axial and/or radial dimensions,

Figure 8 shows a variation of an embodiment of a baseball bat of Figure 7, for which the singular regions are constructed as circular depressions at the periphery of the impact part and are covered by a cylindrical enveloping element and

Figure 9 shows a further variation of an embodiment of a baseball bat, for which the singular regions are constructed as axial depressions at the periphery of the impact part and are covered once again by a cylindrical enveloping element.

The impacting instrument, shown as example in Figure 1, comprises an actuating part BT and an impact part PT, entering into direct dynamic operative connection with the playing object, such as a puck in ice hockey or a ball in lawn or roller hockey. The parts are provided with organizations, which affect the characteristic vibration spectrum and consist of a sequence of a plurality of singular three-dimensional, two-dimensional and one-dimensional regions. These singular regions are determined owing to the fact that they differ from at least a part of their respective surroundings by at least one material and/or shape or dimensional parameter of relevance to vibration and especially to resonance and especially by a different mass, mass density, deformation stiffness and/or damping. Within these sequences, the singular regions in each case form an ordered series, which extends at least over a portion of the impacting instrument.

In the example, a first sequence A1 with singular regions or vibrational elements F1 extends in the longitudinal direction of the actuating part BT.

The vibration elements are constructed here, for example, as sections of a layer, which contain metal and therefore are weight-loaded more heavily than their surroundings, and which are applied by screen-printing.

The characteristics of the sequence A1 are determined by the superimposition of a plurality of singular regions or vibrational elements F1, which, in each case, are in series that are equally spaced apart. These distances vary from series to series and are determined by a whole-number subdivision of a specified section of the length of the actuating part and, moreover, in the sense of a variance of the mutual intervals between the singular regions corresponding to a harmonic series with relative interval amounts $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, indicated in Figure 1 and related in each case to the whole of the length of the section of the actuating part. For the sake of clarity, the representation of the superimpositions in Figure 1 has been omitted after these three first series. Actually, such organizations are continued very much further and up to relatively fine subdivisions. Correspondingly smaller dimensions of the singular regions or of an additional variance of the surface dimensions region are then required for this purpose.

The impact part PT also comprises an actively vibrating organization A2 with singular regions and, moreover, once again in the form of a plurality of superimposed sequences, in each case equidistant from one another. This organization may be constructed as in the case of the actuating part and is indicated only summarily in Figure 1.

In this connection, it should be pointed out that not only progressively or degressively varying graduations or series can be realized with such superimpositions, but also oscillatorically varying graduations or series. In the example of Figure 1, the varying quantities are given by distances between singular

regions. Accordingly, for this small number of superimpositions or sequences, two interval minima between the singular regions of the 1/3 series and the 1/4 series, with reversal between progressivity and degressivity, can already be recognized. However, within the scope of the inventive concept, an oscillatory variance can also be realized possibly with advantage without or with only insignificant or slight superimpositions by directly dimensioning vibration parameters and configuring series.

Quite generally, other vibration parameters, such as material and/or shape or dimension parameters, especially different weights, mass densities, deformation stiffness and/or damping also come into consideration as intervals between singular regions. However, the use of variances in this respect, optionally of constants or of appropriate combinations, at least in one part of at least one sequence, in such a way, that an actively vibrating organization with a plurality of characteristic vibrations results, is important. In this connection, sequences, constructed at least sectionally and at least approximately according to harmonic, but also according to geometric series and extending over five divisions, especially a plurality of such actively vibrating, organized sequences in mutual superimposition, are of special importance. For important applications, sequences extending at least over five divisions, especially a plurality of such actively vibrating, organized sequences in mutual superimposition, have proven to be appropriate or even necessary.

Figure 2 shows an example of a regional sequence in tubular handles, varying in accordance with a geometric series. Two-dimensional, ring-like vibrational elements or singular regions F2, for example, of a metal-containing film or similar screen-printed layers, are disposed here in the longitudinal direction of the tube with mutual intervals at the outside of the tube. The elements F2 have the same width a_1 , whereas their intervals are dimensioned in accordance with a degressive geometric series $x, x^2, x^3 \dots (x < 1)$.

Figure 3 once again shows the use of a geometric series, however with constant intervals a_2 between the vibrational elements or singular regions F3, which follow one another in the longitudinal direction of the tube and the widths a_2 of which, however, are now dimensioned in accordance with a degressively geometric series $x, x^2, x^3 \dots (x < 1)$. In the example, such elements are disposed not only at the outside of the tube, but also at the surface of the inner cavity in quite an appropriate manner.

Figure 4 shows, once again at a tubular actuating part BT, vibrational elements R, which determine singular regions with a spatial extent. In the example, these vibrational elements or singular regions are to be understood as countersunk intercalations, perhaps of a material with a comparatively high mass density, in the wall of the outer surface of the actuating part BT.

The vibrational elements are provided in two multidimensional, essentially orthogonal sequences, namely, in accordance with arrow P2, in the axial direction of the tube and, in accordance with arrow P3, in the peripheral direction of the tube. This signifies an important difference from the superimpositions of Figure 1, which are disposed in each case in one direction. This variant makes possible a differentiated, optionally accordant effect on waves progressing in the longitudinal direction and circumferential direction of the tube and of standing waves extending in these directions.

In the case of the golf club of Figure 5, an actuating part BTG, consisting of a shaft ST and a handle H, as well as a club-like impact part PTG, are indicated. In the longitudinal direction with respect to their mutual axial intervals as well as their axial width and/or their radial thickness, the shaft has thickenings V, which are disposed in sequence. The latter act as singular regions or vibrational

elements in the sense of the invention. It is a question here of a repeatedly superimposed structure in the above described sense with equidistant series structures, their respective equal distances as a whole forming a harmonic series or several such series. This is also the case for the golf club of Figure 6, the shaft ST of which once again has an arrangement of ring-like thickenings R, which are constructed, however, as discrete annular bodies and, accordingly, are concentrated in the axial regions extending in the longitudinal direction of the shaft.

The baseball bat, given as an example in Figure 7, has a stick-shaped actuating part BTB, as well as an essentially cylindrical constructed impact part PTB with ring-like singular regions or vibrational elements SB, which are disposed consecutively in the longitudinal direction of the cylinder with varying mutual distances from one another and also have varying axial or radial dimensions. The optionally approximately cylindrical outer surface of the intact part is in any case maintained smooth, which can be achieved by an appropriate configuration of the outer surface of the ring-like vibrational elements. These annular bodies can be produced, for example, divided or severed only on one side and then inserted in and snapped into appropriate annular grooves of the impact part. In the case of plastic impact elements, a positive embedding and, moreover, covering by an external, hollow cylindrical enveloping element also come into consideration. In view of the generally comparatively large mass of baseball bats, the material of the vibrational elements preferably has a relatively large mass density.

In the case of the variation of a baseball bat of Figure 7, the singular regions are constructed as circular depressions ESZ at the polyphony of an impact part PTBa and covered by a cylindrical sleeve HL. Between these depressions, singular regions or vibrational elements are formed, which represent, with regards to the mutual distances between them or their axial distance from one or both ends of the

organization, an overlapping of a multitude of at least approximately equidistant sequences of these singular regions. With that, sensitive adaptations in accordance with different optimization requirements can be achieved.

The variation of a baseball bat of Figure 9 shows vibrational elements or singular regions, which are formed by depressions ESA extending at the periphery and in the axial direction of, for example, a cylindrical impact part and are covered once again by a cylindrical enveloping element HL. Here also, these vibrational elements overall represent a superimposition of a plurality of at least approximately equidistant sequences of these singular regions, which extend here however in the peripheral direction of the impact part. With one such construction, clear optimizations can be achieved even with relatively short impact parts.

Furthermore, a combination or superimposition of the constructions of Figures 8 and 9 also come into consideration. With that, with respect to a cylindrical section within the impact part or at the inside of the enveloping element, a plurality of radially protruding vibrational elements with an angular or also a rounded cross section, arises. This is a high vibrationally active or resonance-active arrangement of the characteristic frequency spectrum of the impact instrument.